Key Result Area 1: Sustainable Use and Supply

"Water runs like a river through our lives, touching everything from our health and the health of ecosystems around us to farmers' fields and the production of the goods we consume."
—Peter Gleick: The World's Water 2001-2002

Desired Result

An adequate and reliable supply of suitable quality water to sustain human and ecological needs through 2030.

What Does Sustainable Use and Supply Mean?

We must take an integrated approach to managing our water resources to dependably meet current as well as future human and ecological needs. Integrated management for sustainable use and supply means considering the many fundamentally interrelated aspects of the water resource in decision-making, including:

- Water quality and water quantity
- Surface and ground water
- Demand and supply management
- Environmental, social, and economic dimensions
- Legal dimensions

What is the Importance of Sustainable Use and Supply?

The Basin Plan advocates the integrated management of water resources. Integrated management means considering all aspects of the water resource in decision-making. Competition for water to meet the needs of homes, cities, farms and industries is increasing. At the same time, requirements to leave water in the streams and rivers for environmental and recreational uses are also increasing. We need to ensure, for this generation and the next, that the demands we put on our water resources are not in excess of what they can sustain.

Water quality and water quantity are inter-related characteristics.

Traditionally, policy makers have addressed water supply and water quality as separate issues, even though they are in fact fundamentally inter-related characteristics of the water resource. Poor water quality affects water supply by reducing the amount of suitable potable water and by increasing the costs of treatment. Reduced flows in streams may decrease both the capacity of streams to assimilate point and non-point source pollutants, and impair the suitability of water for downstream users and aquatic life. Persistent low flow conditions can lead to warmer water temperature, increased nuisance plant growth and algal blooms, and lower dissolved oxygen levels, causing stress and damage to native aquatic communities. During wet weather, stormwater runoff can increase loadings of bacteria, sediment, salt, pesticide, nutrient, and hydrocarbon from the land. High flow conditions can also scour stream channels and damage the filtration ability of flood plains.

Surface and ground water are inextricably linked.

Another tradition that has confounded wise management has been the artificial separation of ground water and surface water issues. In fact, this separation is a matter of time and location, not of an inherent difference in the resource. Water is a limited resource that is cyclically exchanged between the earth and atmosphere, between soils and streams. A portion of the precipitation that infiltrates the soil re-emerges (after only 72 hours, on average) as flow to streams and lakes. Maintenance of ground water levels, through the natural process of infiltration and recharge, supports stream base flows, surface water quality and healthy aquatic ecosystems.

Demand and supply must be in balance.

We can reduce demand by using water more efficiently. This includes decreasing losses through distribution systems, employing conservation habits and incentives, encouraging technological innovation for increased efficiency, and re-using or recycling water. Options to enhance supply include surface storage, Aquifer Storage and Recovery (ASR), conjunctive use, and stormwater management. Soil conservation and wetland protection also contribute to storage potential by maintaining the natural storage capacity of soils and wetlands.

Environmental and social consequences must be reconciled with economic costs and benefits.

Water is transient, limited in quantity, and subject to profound changes in quality from human use and landscape alterations. Thus, water has social and economic as well as environmental dimensions. Cleaner water in source water streams, rivers and reservoirs requires less treatment, enabling the supply of safe drinking water at a lower cost to residents and other users. Cleaner water means healthier fish, shellfish and waterfowl, lower risk to public health, and healthier economies. Healthy river corridors and waterscapes are aesthetically pleasing. They form a foundation for economically significant recreational activities and enhance the quality of life in our communities.

Diverse legal and regulatory regimes and principles must be coordinated.

Historically, common law has dealt separately with ground and surface water withdrawals. Sound management requires a regulatory framework that establishes uniform principles for ground water and surface water and considers the interrelationships between them.

Laws addressing water quality are distinct from equitable principles governing interstate flow and from state laws governing intrastate water rights. Integrated management involves coordinating these legal regimes. Stormwater management laws and ordinances generally focus on controlling peak flows during and following development, yet the volume of runoff and infiltration amounts can also affect stream flows, water quality and ecosystems, and should also be part of this focus.

Goals for Sustainable Use and Supply

1.1 Equitably balance the multiple demands on the limited water resources of the Basin, while preserving and enhancing conditions in watersheds to maintain or achieve ecological integrity.

1.2 Ensure an adequate supply of suitable quality water to restore, protect and enhance aquatic ecosystems and wildlife resources.

1.3 Ensure an adequate and reliable supply of suitable quality water to satisfy public water supply and self-supplied domestic, commercial, industrial, agricultural, and power generation water needs.

1.4 Ensure adequate and suitable quality stream flows for flow-dependent recreational activities.

GOAL 1.1: Equitably balance multiple demands on the limited water resources of the Basin, while preserving and enhancing conditions in watersheds to maintain or achieve ecological integrity.

This is a two-part goal. To equitably balance multiple demands, it is essential that we first understand the types of human and ecological demands being made on the hydrological system. The second part of Goal 1.1 is to set realistic targets for preserving and enhancing conditions in watersheds to maintain or achieve ecological integrity. This requires a clear understanding of existing conditions, and of the needs of aquatic and riparian populations. Those watersheds that currently approximate natural conditions should be protected to preserve their ecological and hydrological functions and those that have been degraded should be restored or enhanced.

Assessing current water uses. Improving our understanding of water use will help us determine what constitutes efficient use of the resource and what may be deemed essential and non-essential uses. The generation of reliable data requires accurate and up-to-date records on all ground water and surface water withdrawal allocations, wastewater discharge permits, and connectivity among withdrawal, use, and discharge points. Data management problems currently hamper the development of a precise use data set for all watersheds in the Basin. However, existing information for individual watersheds can be used to estimate water use in other watersheds with similar conditions.

A water budget is a description of the fate of water resources in a watershed, as illustrated in Figure 3. Budget "inputs" include precipitation and imports (transfers into the system). Water inputs will become:

- Evapo-transpiration (ET) into the atmosphere
- Direct flows to surface water bodies (runoff)
- Indirect contributions to stream flow through the soil and the water table
- Recharge to deeper ground water aquifers
- Consumptive losses associated with human use
- Exports from the watershed

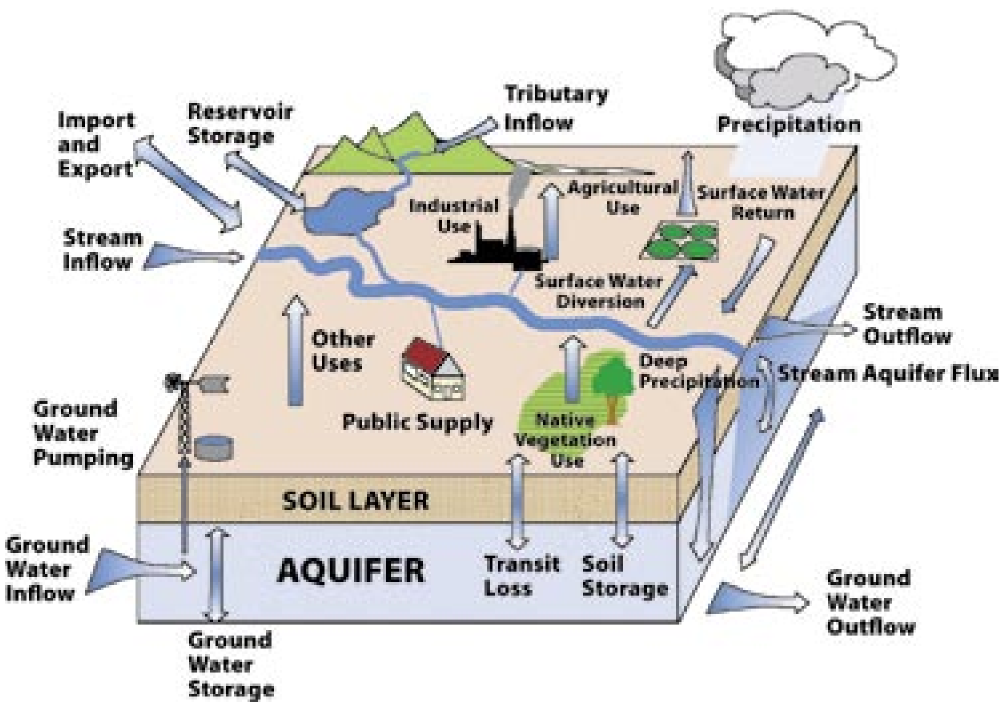


Figure 3: Conceptual water budget, illustration courtesy of Colorado Division of Water Resources, Office of the State Engineer

The proportion of water inputs that arrive at each destination is determined by climate; by geology, soils and topography; by the land use attributes of a watershed; and by the way in which we use water resources. Water budgets yield an average annual accounting of water volumes and do not reflect seasonal variation. Although the water budget approach has limitations, a pilot study is currently underway as part of a USGS-DRBC partnership to assess the feasibility of using water budgets as a screening tool for watershed assessments.

Calculating water budgets on a realistic scale. The issue of watershed scale is important (see "Defining the Appropriate Scale for Calculating Water Budgets.") USGS has assessed ground water availability for sub-basins within the Southeastern Pennsylvania Ground Water Protected Area, but implementation of this Plan will require a methodology sanctioned collectively by the Basin states for determining ground and surface water availability.

DEFINING THE APPROPRIATE SCALE FOR CALCULATING WATER BUDGETS

The Natural Resource Conservation Service classifies watershed units by Hydrological Unit Code (HUC). The Delaware River Basin includes 236 watersheds classified as HUC 11. These average about 55 square miles in size. By contrast, there are only twelve HUC 8 watersheds delineated by USGS for the Basin. However, these may be too large for the purpose of developing water budgets. Smaller units (HUC 14 scale) number in the thousands, creating a practical barrier to developing a Basin-wide coverage of water budgets at that watershed scale in the short-term. However, knowledge of watersheds at smaller scales may be appropriate for local planning purposes, for assessing impacts, and for supporting restoration efforts.

Assessing in-stream flow and freshwater inflow requirements. Understanding the needs of aquatic ecosystems is essential to several goals of the Basin Plan. It is a prerequisite for 1) assessing the amount of water available for allocation; 2) setting standards for improving conditions in watersheds and restoring natural functions in stream corridors; 3) protecting threatened and endangered species; and 3) Improving operating plans for reservoirs.

Developing strategies for the allocation of water. Once both human and ecological needs are understood we are ready to address the challenge of achieving an equitable balance among the multiple demands on the hydrological system. Prudent allocation strategies may include curtailing water uses during drought conditions through allocation decisions or use restrictions, and allocating water to areas with limited water resources as determined by calculated water budgets and availability assessments. Allocation strategies will need to honor the rights of the parties defined in the 1954 US Supreme Court Decree.

Developing tools for assessing ecological integrity. The development of indices of ecological integrity that integrate the physical, biological and chemical requirements of healthy aquatic and riparian ecosystems is critical for realizing restoration and enhancement goals.

- Key species or characteristics that are especially sensitive to changes in water availability or quality should be identified.
- Understanding the relationship of ecoregions, ecological communities, and watersheds is integral to the development and application of relevant assessment protocols.
- Setting appropriate criteria and standards for assessment and restoration within the Basin's ecoregions are necessary to make sustainable water allocation decisions.

GOALS 1.2, 1.3 and 1.4: Ensure adequate supplies of suitable quality water for:

Goal 1.2 Aquatic ecosystems and wildlife

Goal 1.3 Projected public water supply and self-supplied domestic, commercial, industrial, agricultural, and power generation

Goal 1.4 Flow-dependent recreation

Goals 1.2 through 1.4 speak to meeting the water quantity and quality needs of the River Basin for a wide range of uses through the planning horizon of 2030.

Assessing needs and projecting demand.

Water budgets and ground water availability studies are examples of the types of assessments that are currently underway. This work, along with an understanding of aquatic ecosystem needs, provides the foundation for improving water allocation decisions.

Identifying the freshwater needs for aquatic ecosystems and wildlife. Aquatic ecosystems and wildlife represent important users of the Basin's waters. Protecting water quality for those uses is an integral part of the Clean Water Act, and of State and DRBC regulations. Fresh water must be available in adequate quantities for drinking, feeding, cleansing and reproduction. Resilient, healthy ecosystems adapt to changes within a natural range of variability. Changes that push the limits of that range may cause irreparable harm to communities of water-dependent animals and plants. Therefore, it is important to understand ecosystem function, and the limits to the range of conditions that ecosystems and natural communities will tolerate.

Water availability varies with geographic location and seasonal fluctuations in precipitation and temperature. It is also susceptible to change as a result of the patterns of human settlement and water use. For example, the ways in which water is allocated to uses within and outside of the stream (public water supply, industrial, commercial, agricultural, power production, etc.) and how water is returned to the stream (when, where, in what amounts, and of what quality) can have a great influence on how streams provide for ecosystem needs.

Projecting demand for water for various human purposes, including how much, when, and where water will be needed. Before we can ensure adequate water resources for human purposes into the future, we need to generate projections of population and sector water demand. These projections can then be compared to the water determined (through the water budget and available ground water assessments) to be available for allocation—that is, available for use without impairing the ability of the water resource base to support healthy ecosystems. This will require developing a methodology and range of assumptions to which the Basin partners are agreeable. Figure 4 shows regional population change in the Basin between 1990 and 2000.

Developing projected water needs for all use sectors, including estimates of consumptive use, water distribution system losses and the potential effects of various water conservation programs. Projections must take into account possible alternative future conditions. This will require making not a single projection but a range of projections, reflecting a range of possible scenarios.

- Figure 5 illustrates how differing future water demand scenarios require different levels of water supply development. This Plan requires that a study of future water demands be undertaken to enable us to plan the necessary supplies through the year 2030. While we should focus on what the most likely (forecast) outcome will be, we can also examine the cost and benefits of alternative (high and low) water demand scenarios and the implications for resource development. This approach also provides a method for testing the sensitivity of water use projections.

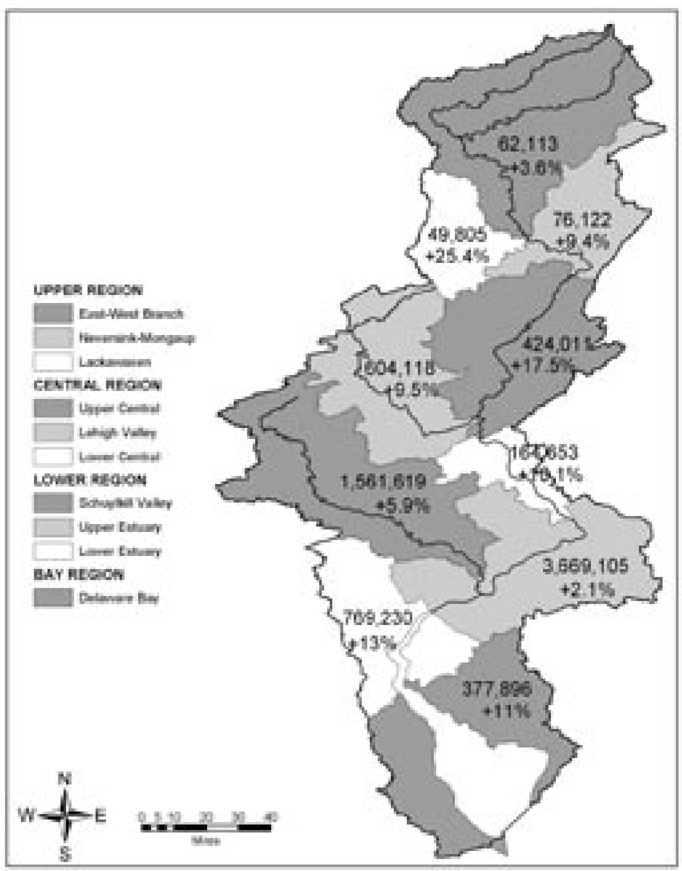


Figure 4: 2000 population by region showing percentage change from 1990 to 2000

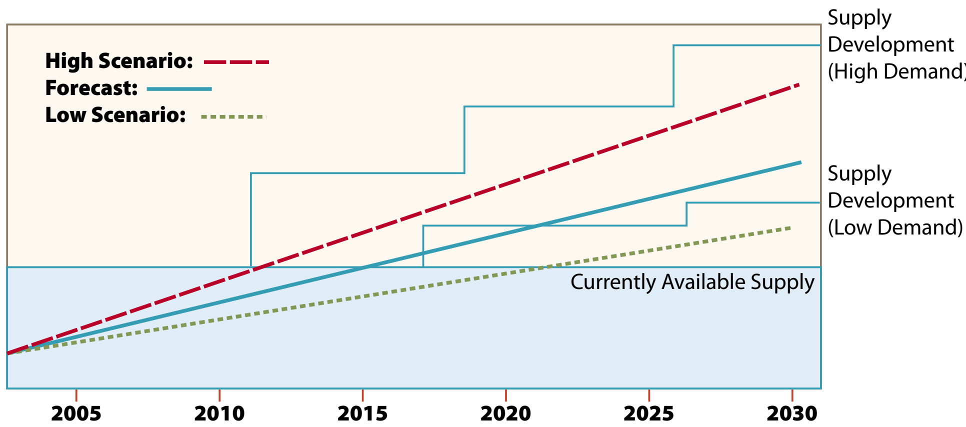
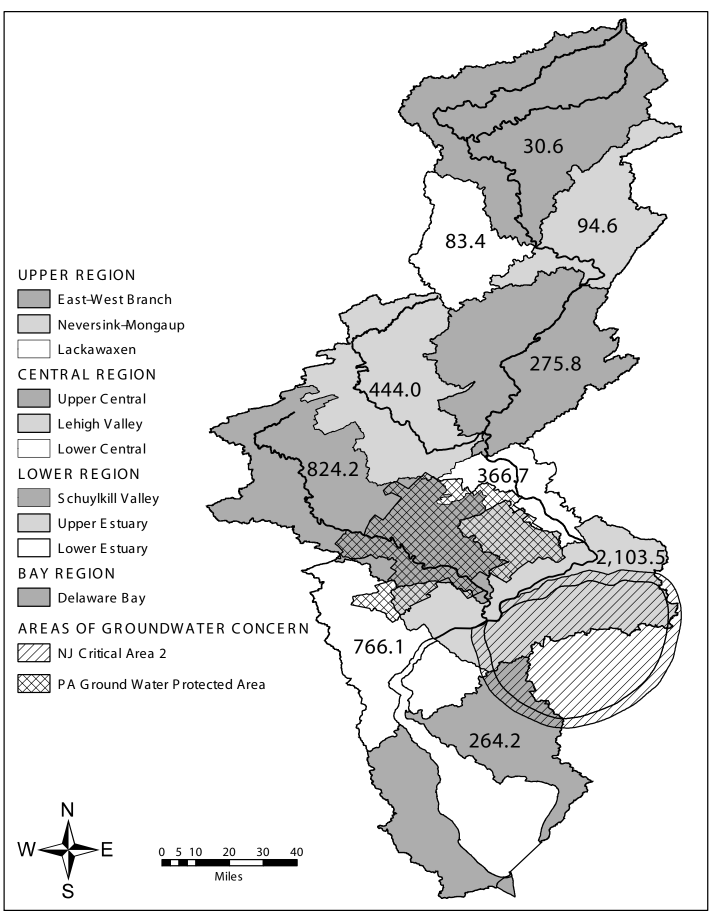


Figure 5: Schematic representation of scenario-based water demand forecasting

Ensuring adequate supplies for growing populations also entails understanding and managing how and where growth will occur in order to fulfill expected demand and have the least detrimental impact on natural systems. If water stressed areas are identified for growth, then solutions to water supply problems need to be determined and planned. Lessons learned and legal constraints established in connection with previous decisions on water transfers should be incorporated into water resources decision-making in the future to meet state, regional and local plans for growth management as well as ecological needs.

- The map in Figure 6 shows existing population density in the Basin regions as of 2000. Figure 5 illustrates areas in Pennsylvania and New Jersey where special withdrawal restrictions are in effect based on concerns for ground water levels.

Figure 6: 2000 population density, persons per square mile



Assessing the flows needed for recreational purposes and plan for flow management. This task includes several steps: 1) Define the scope of flow-dependent recreational activities to be addressed; 2) Determine the needs of these activities; and 3) Set operation strategies to be applied during periods of normal and subnormal precipitation in the portions of the Basin where reservoir releases are managed. Legal restrictions on the use of reservoir storage should be examined.

Ensuring water of suitable quality means making sure that water quality meets or exceeds the needs of its intended use.

Assessing existing water quality. To determine the actual concentration of a water constituent at an in-stream site or sites requires field measurements and laboratory analysis. Data must be collected over a period of time to adequately reflect the natural range of hydraulic and climate factors which affect water quality. A significant commitment of time and resources is necessary since information needs to be collected for a duration sufficiently representative of the natural variations or changes in natural systems that can be expected to occur.

Monitoring conditions. Water quality conditions must be monitored with sufficient frequency in the main stem and the tributaries to reveal a trend of quality maintenance, improvement, or degradation. Strong coordination and cooperation among Basin partners is required to develop a realistic and integrated view of the Basin's water quality. Specifically, Basin partners must be able to coordinate monitoring efforts, agree on methodologies and criteria for sampling and assessment, and agree on the advice to be provided to water resource users. Coordination and cooperation is necessary to conserve fiscal and staff resources and provide adequate and reliable data. Ultimately, it will determine the quality and consistency of the water quality information collected and used in the Basin.

- Building on existing monitoring and indicator programs, the challenge will be to determine robust sets of indicators for each of the Objectives in this Plan.

Maintaining good water quality. One of the most important tasks we face, this will require setting and agreeing on permitting standards for discharges as well as providing tools and information that will prevent additional impacts from land development and management activities. Approaches may include: 1) Anti-degradation programs (e.g. state protections for high quality and exceptional value streams, the DRBC's Special Protection Water designations and federal Wild and Scenic Rivers designations); 2) Stormwater management programs; 3) Water quality-based trading programs (offsetting impacts from new or expanded discharges by equivalent reductions from other sources within the watershed).

- We face a major challenge to "keep our clean water clean" in areas where we expect increases in growth and development activity in the future.

Improving water quality. Where standards are not being met for designated uses, we must develop regulatory and non-regulatory strategies to identify pollutant sources and to achieve the standards. An important regulatory program is that of assigning Total Maximum Daily Loads (TMDLs) to the water body when levels of pollutants in the water body exceed standards. Other approaches can be used. For example, a trading program might be used to more cost-effectively meet standards through trading between existing point and non-point sources.

- Allocating pollutant loads for discharges and non-point sources resulting in upgrades to treatment facilities and the use of Best Management Practices (BMP) with water quality controls is another strategy.
- Vigilant monitoring and development of innovative strategies to mitigate potential new impacts will be necessary to keep water quality from further impairment.

Ensuring "fishable" waters. Fish bio-accumulate certain chemicals and toxins in their flesh. When accumulation reaches levels higher than those deemed safe for human consumption, States post health advisories against eating even limited amounts of certain species from specified water bodies or stream segments. In addition to the food chain impacts and implications for human health, the quality and abundance of fish species also affect the viability of commercial and recreational fishing and associated tourism economies.

- Developing stormwater management programs for existing development is one strategy for improving water quality. See also Goal 2.3 and Goal 3.2.

Cannonsville Reservoir, one of three New York City water supply reservoirs in the Basin.

WATER QUALITY — VALUE OF STREAMBANK STABILIZATION

According to a recent study, efforts to stabilize streambanks to reduce erosion also removes substantial quantities of phosphorus from non-point sources. Phosphorus is a nutrient that contributes to unwanted algal growth and reduction of dissolved oxygen in streams and lakes.

Reduction in the amount of phosphorus (along with sediment and nitrogen) associated with streambank stabilization provides potential economic benefit through reduced treatment costs and adverse environmental impacts.
Source: US Army Research and Development Center. www.wes.army.mil/el/wq.

"Assessment of Environmental and Economic Benefits Associated with Streambank Stabilization and Phosphorus Retention" available at www.wes.army.mil/el/elpubs/pdf/wqtnam14.pdf.